**Annals of Clinical and Analytical Medicine**
*Original Research*

# Results of surgical treatment with proximal femur nail in adult femur pertrochanteric fractures



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**Abstract**

Aim: Proximal femoral nails are widely used in the treatment of pertrochanteric fractures, as they can be applied in a shorter time and with less bleeding, with their more stable biomechanical properties during axial loading. In this retrospective study, conducted in our institution, we aimed to determine the effectiveness of PFN, especially in various osteoporotic conditions, mental health conditions, anesthesia risk, functional outcomes and mortality

Material and Methods: Functional and radiologic results of 109 consecutive patients with intertrochanteric femur fractures, who have undergone osteosynthesis with proximal femoral nail between October 2009 and January 2015, were examined retrospectively. In addition to demographic characteristics, the type of fracture, comorbidities, type of trauma, duration from the moment of fracture to surgery, surgery duration and complications, presence of union and position of the implant were evaluated clinically and radiologically. The American Society of Anesthesiologists (ASA) scale was used for surgical risk assessment. The Harris Hip Scoring System was used for functional evaluation.

Results: Fifty-nine patients were male and 50 were female. The mean age was 77,69 (17 -102) years. The mean follow-up time was 32,9 (12-61) months. The etiology was as follows: a simple fall in %89.9 of cases, a fall from height in %7,3 of cases and motor vehicle accidents in %1,8. Operative procedures were performed within an average of 3,54 days after admission to our hospital (range 0-17 days). The average length of hospital stay was 7,76 days (range 2-56 days). Nine patients had complications related to the fracture. The mean score on the Harris scale at the last follow-up was 79,6 (48-100). The mortality rate in the first year was %29,6. A high ASA score and age over 80 years were found to generate a statistically significant increase in the risk of mortality and poor functional outcome.

Discussion: Pertrochanteric fractures are usually diagnosed in elderly patients due to low energy traumas. The first choice of treatment must be surgical for an early return to pre-fracture activity levels. The proximal femoral nail is a reliable, safe and effective treatment method for pertrochanteric fractures due to its advantages such as application with closed reduction, providing anatomic and biological fixation, short surgical time, low blood loss and complication rate, and the possibility of early weight-bearing.

**Keywords**

Intertrochanteric fractures; Proximal femoral nail; Harris hip score

DOI: 10.4328/ACAM.20373 Received: 2020-10-15 Accepted: 2020-11-14 Published Online: 2020-11-24 Printed: 2021-06-01 Ann Clin Anal Med 2021;12(6):653-657
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## Introduction

Classically, fractures occurring in the region between the large trochanter and the small trochanter are called intertrochanteric femur fractures. Proximal femoral fractures involve some unique challenges in elderly patients with increased comorbidities and predisposition factors and conditions such as osteoporosis [1-4]. In the whole world, the incidence of these fractures increases due to the prolonged life expectancy [5]. In the United States, there are approximately 200000 hip fractures per year, and this number is expected to increase to 500000 per year in 2040 [6]. In a study investigating the incidence of hip fracture in Turkey, in the year 2010, 17800 hip fractures are expected to rise to 50,000 in 2035 increasing by about three times [7].

The purpose of the treatment of intertrochanteric fractures is to minimize the medical complications and technical errors that may arise, and to give the patient ability to move safely again, reaching the patient's pre-fracture activity level.

Proximal femoral nails are widely used in the treatment of these fractures as they can be applied in a shorter time and with less bleeding, with their more stable biomechanical properties during axial loading. In this retrospective study conducted at our institution, we aimed to determine the effectiveness of PFN, especially in a variety of osteoporotic conditions, mental conditions, anesthesia risk, functional outcomes, and mortality [8, 9].

## Material and Methods

Informed consent was obtained from all patients and ethics committee approval was obtained from our institution for the study. Between October 2009 and January 2015, 109 patients who underwent osteosynthesis with Veronail® proximal femur nail due to pertrochanteric femur fracture were retrospectively evaluated. Patients with extracapsular, pertrochanteric fractures evaluated as AO Type 31-A1, Type 31-A2 and Type 31-A3 and subgroups were included in the study.

Patients who did not have the ability to walk before the fracture, patients with pathological fractures, or previous surgical history of the ipsilateral femur and hip, and fractures extending more than 5 centimeters distal to the trochanter minor were not included in the study.

The demographic data, the nature of trauma, the type of fracture, and concomitant systemic diseases accompanying other fractures were recorded. The preoperative health status was evaluated by obtaining a history of any comorbid disease and medication, and by determining the physical health status according to the American Society of Anesthesiologists (ASA).

Electrocardiogram, electrolytes, liver and kidney function tests, complete blood count, bleeding time and serology tests were performed for surgery preparation. At the time of admission, both hip anteroposterior, femoral anteriorposterior and lateral including the broken side of the hip were taken.

The duration of the operation, the type of anesthesia, and the number of blood transfusions needed were recorded. The duration of hospitalization before and after the surgery was evaluated.

### *Surgical Technique*

Veronail® proximal femoral nail, which allows compression in the double-axis with double compressive locked telescopic cephalic screws, was used for stabilization. After the patients were anesthetized, they were placed on the fracture table in the supine position. Closed reduction was performed under fluoroscopy. After nail insertion, telescopic screws were used for AO 31.A1 and AO 31, and A2 fractures for proximal fixation. In cases of AO 31.A3 fractures, fixed screws were used in the convergence configuration. Nail distal locking was performed statically and dynamically.

### *Postoperative course*

Infection prophylaxis with second-generation cephalosporins and deep vein thrombosis prophylaxis with low molecular weight heparin were applied to all patients until the first month. Patients with stable trochanteric fractures were mobilized with the aid of a walker by loading as much as they could tolerate on the first postoperative day. Reinforcement rehabilitation of the knee and hip circumference muscles was started. Patients with unstable trochanteric fractures were applied partial weight-bearing with a walker during the first 6 weeks after surgery, and weight-bearing ratio were increased after 6 weeks. The patients were called to the outpatient clinic controls for suture removal in the second week after surgery. The functional status assessment was performed in conjunction with radiological evaluation in patients who were invited to the control visits at the 6th week, 6th month, and 12th month, and then once a year.

### *Radiological evaluation*

We took into account the union in the fracture, the position of the implant, the degree of secondary varus, calcification at the tip of the trochanter major, and the penetration into the hip joint of proximal screws.

### *Functional Evaluation*

According to the Harris Hip Scoring system in functional evaluation, 90-100 points: excellent, 80-89 points: good, 70-79 points: moderate and <70 points: evaluated as bad results. The evaluation in the first year after the operation was taken into consideration. Patients who died in the first year were excluded from functional evaluation.

### *Statistical Analyses*

SPSS 22.0 version package program was used in the statistical analysis of the data in our study. Categorical measurements were summarized as numbers and percentages, while numerical measurements were summed as mean and standard deviation, median and minimum-maximum. Shapiro Wilk and Kolmogorov-Smirnov tests were used for normal compatibility tests. Student-T Test and One-Way ANOVA were used for numerical data that conformed to normal, and Mann-Whitney U and Kruskal-Wallis Tests were used for non-normal data. In the categorical data, Pearson Chi-Square and Yates Chi-Square were compared, and in comparing the two numerical data, Pearson's Correlation Test was used for the data that conformed to the norm, and Spearmen Correlation was used for non-normal data. A p-value of less than 0.05 was considered statistically significant.

## Results

The demographic characteristics of the patients, ASA classification, causes of injury and the results of the patients whose Harris hip score was calculated in the study are summarized in Table 1. Twenty-three of 109 patients died

**Table 1.** The demographic characteristics of the patients, ASA classification, causes of injury and the results of the patients whose Harris hip score was calculated

| Number of patients | 109 |
|---|---|
| Sex | |
| Male | 59 (%57.5) |
| Female | 50 (%42.5) |
| Mean Age | 77.6 years (45-101) |
| Male | 73,91 years (45 -100) |
| Female | 83.27 years (59-101) |
| Cause of injury | |
| Simple Fall | 100 (%91.2) |
| Motor vehicle accident | 2 (%1.8) |
| Fall from height | 7 (%6.4) |
| ASA Classification | |
| I | 7 (%6,4) |
| II | 37 (%33,9) |
| III | 59 (%54,1) |
| IV | 6 (%5,5) |
| Harris Hip Score | |
| Poor | 23 |
| Fair | 20 |
| Good | 22 |
| Excellent | 15 |
| Type of Anaesthesia | |
| Regional | 85 (%78) |
| General | 24 (%22) |

ASA: American Society of Anesthesiologists status of physical health.

**Table 2.** Concomitant disorders of paients (COPD: Chronic obstructive pulmonary disease)

| Concomitant Disorders | | |
|---|---|---|
| Hipertension | 37 | %33,94 |
| Diabetes Mellitus | 21 | %19,26 |
| COPD | 19 | %17,43 |
| Heart Failure | 16 | %14,67 |
| Chronic Renal Failure | 12 | %11 |
| Liver Failure | 2 | %1,83 |
| Alzheimer Disease | 3 | %2,75 |
| Serebrovascular Disease | 3 | %2,75 |
| Malignancy | 10 | %9,17 |

**Table 3.** The distribution of fractures according to the AO classification system

| Fracture Type ( AO Classification) | | |
|---|---|---|
| Stable | 31A1.1 | 8 (%7.3) |
| | 31A1.2 | 24(%22) |
| | 31A1.3 | 3(%2,8) |
| | 31A2.1 | 10( %9,2) |
| Unstable | 31A2.2 | 20( %18,3) |
| | 31A2.3 | 22(%20,2) |
| | 31A3.2 | 4(%3,7) |
| | 31A3.3 | 18(%16,5) |
| | Total | 109 |

within 3 months after surgery, 2 within 3-6 months and 4 within 6-12 months. Patients followed up for less than 12 months were excluded from the functional results. The remaining 80 patients were followed up for an average of 32.9 months, with a minimum of 12 and a maximum of 61 months. Patients were evaluated with the Harris Hip Score (HHS) for fracture union and functional results.

In our study, the average of HHS in 80 patients with a follow-up period of at least one year was 79.6 (48-100). There was no statistically significant difference between HHS and age. In the statistical evaluations performed by dividing the patients into groups under the age of 70, between the ages of 70 and 80, and above the age of 80, it was observed that the HHS values of the patients showed a significant decrease with the advancing age ($p < 0.001$). When we tested homogeneity between groups in post hoc analysis, it was found that variance homogeneity was different ($p < 0.001$). In the T-mean Post Hoc test performed on groups with different variance homogenity, the statistical difference was significant when comparing the group of patients over 80 years old with other groups.

Concomitant diseases are shown in Table 2. Most common concomitant disorders were hypertension, diabetes mellitus and chronic obstructive pulmonary disease. The patients were operated on an average of 3.54 days (0-17 days). Patients with a mean hospital stay of 3.32 days (1-50 days) after surgery were found to have a mean hospital stay of 7.76 days, with a pre-operative waiting period. No statistically significant difference was found between the length of preop hospital stay and the mortality rate ($p = 0.817$). The average number of transfusions was calculated as 0.9 units. A statistical difference was found between transfusion and mortality risk ($p = 0.012$). Also we observed that the type of anesthesia had no effect on mortality.

The distribution of fractures according to the AO classification system is shown in Table 3. When the patients were compared according to death risks associated with subtypes of AO classification, there was no statistically significant difference between fracture stability and risk of death within one year ($p = 0.267$). There was no statistically significant difference regarding the effect of fracture stability on HHS ($p = 0.246$). It was found that age below 70 and above in A3.3 fractures caused a statistically significant difference in HHS ($p = 0.029$)

Nine patients had complications related to the fracture. There were two proximal screws cut-out with secondary varus malposition, one nonunion and implant failure (Figure 1), and one femoral shaft fracture at the level of the distal screw after a simple fall. Also, one patient with non-union was revised using plate screw osteosynthesis and an iliac crest autograft. We encountered pulmonary embolism in three patients and surgical site infection in one patient. Unfortunately, all patients with pulmonary embolism died within one week of surgery. No patients had an iatrogenic femoral shaft fracture during surgery. Patients with a secondary varus and proximal screw cut out did not accept secondary surgery.

In the one-year follow-up, the mortality rate was calculated as 29.6%. The one-year death rate in patients over 80 years of age was found to be 42.6%. When the patients were divided into groups under the age of 70, between 70 and 80 and above 80,

a statistically significant difference was found (p <0.001), and the risk of death was higher in patients over 80 years of age. In the statistical evaluation made using Pearson chi-square test, it was observed that there was an increase in ASA classification and an increased risk of death (p = 0.029).

## Discussion

Although hip fractures are the most common traumatic injury in the older age population, they are also one of the most important causes of morbidity and mortality despite current medical advances and current approaches in preoperative and postoperative follow-up. Management of these patients becomes more complicated due to accompanying health problems. Mortality rates can be up to 10% within 30 days after surgery, but this rate varies between 20% and 30% at the end of the first year [10-12]. In our study, the mortality rate was found to be 26% over a period of one year, and the result was found to be consistent with the literature.

In their study, Hue and colleagues stated that advanced age, male gender, limited ability to walk preoperatively, difficulty in performing daily life activities, high ASA score, low mental capacity, weak cognitive functions, dementia, diabetes, cancer and heart disease are early mortality risk factors after hip fracture [13]. Elderly patients with comorbid diseases have an increased risk of mortality in the postoperative period. The risk of mortality increases in patients with impaired homeostasis, anemia, dehydration, and prolonged preoperative preparation period [11, 14-16]. In our study, although the one-year mortality rate was 35% in patients with more than five days of preoperative preparation period, we found that this increased time did not cause a statistically significant increase in mortality risk.

The Veronail® implant, which we used in our study, does not require medullar reaming, it is thin, its tip is blunt, it has two screws that can be sent to the femoral neck proximally, and distal screws can be locked both statically and dynamically [17, 18]. Since the proximal screws are locked into the nail, Z effect is not observed, and compression is provided by the telescopic screw structure. The proximal screw sent to the neck can be sent as a convergent. This feature can reduce the incidence of screw peeling by allowing more bone stock to remain proximal to the screw.

During the surgery, it was shown that after reaming the nail entry point, loss of reduction can occur while attaching the nail. Xu and colleagues reported that during intertrochanteric fracture surgery, there may be reduction losses during the proximal femoral nail applications due to improper nail insertion, inadequate imaging with scopy, excessive traction and removal of auxiliary reduction tools prior to complete stabilization. Also, it was stated that lag screws or helical blades may promote reduction loss as the twisting forces will cause rotational deformation at the proximal fragment [19]. The proximal fracture fragment is more resistant to rotational forces due to the presence of two screws in the Veronail®. Unlike similar systems (PFN-A®, Synthes 17 mm) (InterTan®, Smith and Nephew 17mm), in Veronail®, the proximal nail diameter is smaller (15 mm). This feature benefits the preservation of bone stock. In addition to tolerating minor errors during proximal reaming, it also prevents reduction loss while attaching the nail. It is evident that nail design has great importance in reducing the complication rate after fracture treatment. When patients who underwent osteosynthesis due to intertrochanteric femur fracture were examined, it was reported that the need for secondary surgery was 3% in the intramedullary hip screw, 6% in slide screw plating and 4-12% in PFN® [20]. In a study conducted by Liu et al., they reported that 20.5% of 223 patients developed mechanical complications [21]. In our study, three of 109 patients underwent secondary surgery. Since two patients with lag screw cut-out did not want to be operated, revision surgery was not performed. The reoperation requirement ratio was calculated as 6.42%. As a result, complication rates with Veronail in our study are lower than using other intramedullary implants reported in the literature [22-24].

### *Conclusions*

Although the efficiency of proximal femur nails in the treatment of intertrochanteric fractures is obvious, the absence of Z-effect in the implant we use is the advantage of such systems. The low mechanical complication rates of the implant are remarkable.

***Scientific Responsibility Statement***

*The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.*

***Animal and human rights statement***

*All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.*

***Funding:*** *None*

***Conflict of interest***

*None of the authors received any type of financial support that could be considered potential conflict of interest regarding the manuscript or its submission.*

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***How to cite this article:***
*Emre Ergen, Mustafa Karakaplan, Bünyamin Arı, Okan Aslantürk, Özgür Yılmaz, Erkay Nacar. Results of surgical treatment with proximal femur nail in adult femur pertrochanteric fractures. Ann Clin Anal Med 2021;12(6):653-657*